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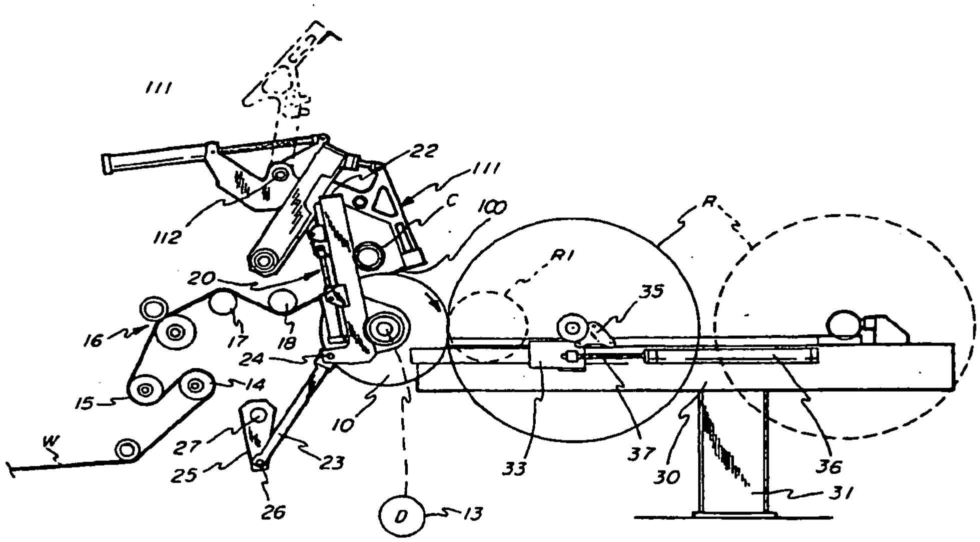

(57) Abstract

In apparatus for continuously winding a web material into rolls on successive cores which are mounted on successive core shafts and driven by surface engagement with a driving drum (10) rotating at constant speed, the core shaft being supported in primary arms during the start and initial winding of each roll, and being then transferred to secondary supports (30), provision is made for supplementing the surface driving of the winding roll throughout the complete cycle by applying a driving force directly to each core shaft in both the primary arms wherein the roll is started and on the secondary supporting means whereon winding of the roll is completed. By suitably controlling this direct drive to cause the core shaft to try to overspeed its speed which is controlled by the drum, the resulting torque will cause the web to wind correspondingly more tightly.

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CONTINUOUS WINDER FOR WEB MATERIALS

This invention relates to apparatus and a method for the continuous winding of web materials. The apparatus is of the general type shown in the co-owned Evans et al, U. S. Patent No. 2,703,683 of 1955 and Phelps, U. S. Patent No. 3,202,374 of 1965. Such reels include a driving drum for surface driving each winding roll, and primary arms which support each successive new roll core while the web is starting to wind thereon, and wherein the new roll is then transferred to secondary means such as ways for completion of the winding.

Winders of this type have in the past been used most often to receive paper webs from a paper machine or from a converting line to form successive large rolls having the complete web width wound thereon, and these large rolls were then taken to a different station where they could be unwound, slit to desired smaller widths, and rewound with proper roll density control. In order to increase productivity and decrease production costs, the modern trend is to slit wide webs before they are wound at all, and then to wind the resulting individual narrow webs into rolls of the proper quality.

Problems have been encountered in the use of prior art reel-type winders in this manner, particularly from the standpoint of achieving optimum degrees of roll hardness throughout the roll, specifically when winding non-woven fabric. The conventional practice for this purpose has been to attempt to achieve controlled hardness by the combined forces of nip pressure between the roll and the driving drum and web tension as the web is fed to the drum.

The above Phelps patent taught that a hard tight start on the core could be obtained by starting the winding of the roll by a drive acting in effect on the axis of the core while the core is supported in the

primary arms out of engagement with the driving drum, and thereafter bringing the winding roll into engagement with the drum for surface driving by the drum. However, Phelps also taught that the axially applied drive should be disconnected as soon as the winding roll is brought into driven surface engagement with the driving drum.

The present invention was made as a result of realization of the fact that the existing technology did not provide adequate control of the density of wound rolls of relatively bulky web materials such as non-woven fabrics, particularly in conjunction with a slitting operation prior to winding the resulting multiple rolls. In the course of developing the apparatus and method of the invention by which this problem is overcome, however, it was also realized that the invention is not limited to bulky web materials and can be successfully utilized with other web materials.

The major novel characteristic of the invention is that it provides for driving each successively wound roll both by surface engagement with the driving drum and by a driving force applied to the axis of the roll from the start of the roll to its completion, i.e. during the interval wherein the new roll is being started on a core supported in the primary arms and also after it has been transferred to the secondary ways or other secondary supporting means.

More specifically, while surface driving of a winding roll by a driving drum inherently maintains the surface speed of the roll matching the surface speed of the drum, the angular (rpm) speed of the roll constantly decreases as its diameter increases. The invention provides for supplementing the surface driving of the winding roll throughout the complete winding cycle by applying a torque mode driving force to the core shaft which supports the winding roll both in the primary arms

wherein the roll is started and on the secondary supporting means where winding of the roll is completed.

It is of course apparent that so long as the winding roll is driven by surface engagement with the driving drum, the angular speed of the core shaft will be determined by the surface speed of the roll winding thereon, and it cannot be changed by the added center drive. However, the center drive will cause the core shaft to try to overspeed its speed which is controlled by the drum, and this force will be converted into torque that will cause the web to wind correspondingly more tightly on the core.

A special feature of the apparatus of the invention is that the center drive to the core shaft while it is supported in the primary arms originates from a stationary motor through a transmission system carried by one of the primary arms which is of such structure and mode of operation as to be equally effective in all positions of the core shaft in the primary arms as the shaft moves radially of the driving drum in response to the increase in diameter of the web material wound thereon.

Thus in a typical sequence, the new segmented core in the primary arms, which has segments corresponding to the width of each slit portion of the web is mounted on a common support, is brought up to the proper surface speed by its center drive before it is in contact with the web which is traveling around the drum to the roll winding on the secondary ways. Then when the web sections are transferred to the segments of the new core, by engagement of the core segments with the web against the drum, the core shaft is driven both by surface contact with the drum and by the center-applied drive, but the latter drive is shifted from maintaining the surface speed of the new slit roll matching that of the drum to applying predetermined torque to the winding

roll that supplements the surface drive and thereby controls the hardness with which the web begins and continues to wind on the new core.

In addition, the apparatus of the invention includes a second torque mode drive associated with the carriages which support each successive winding roll on the secondary ways. Provision is made for transferring the center applied drive from the drive carried by the primary arms to the torque mode drive of the core shaft while it is carried by the secondary way carriages before the new roll is released from the primary arms so that they can return to the proper position for starting the next roll.

Fig. 1 is a side elevation showing a winder installation in accordance with the invention;

Fig. 2 is a side elevation, on a larger scale, of the primary arm assembly on the same side of the winder shown in Fig. 1;

Fig. 3 is an elevational view of the arm assembly, looking from right to left in Fig. 2;

Fig. 4 is a partial elevational view of the other side of the winder from the side viewed in Fig. 1;

Fig. 5 is a fragmentary view in elevation looking as indicated by the line 5--5 in Fig. 4;

Fig. 6 is an enlarged fragmentary section on the line 6--6 in Fig. 4; and

Fig. 7 is a fragmentary view looking downward as indicated by the line 7--7 in Fig. 5.

Fig. 1 illustrates a continuous winder installation in accordance with the invention. The driving drum 10 has its opposite end journals supported in end frames 11 and 12, and it is driven in conventional manner by a main drive 13 at a constant surface speed matching the speed at which a non-woven fabric web W is fed thereto. The web feed may also be conventional, and those of its component parts shown in Fig. 1 include a

pull roll 14 from which the web advances around a tension transducer roll 15, through a slitting section 16 and then around successive spreader rolls 17 and 18 to the drum.

Each of a pair of primary arm assemblies 20 includes an arm 22 mounted on the respective end frame 11 or 12 for pivotal movement about the axis of drum 10. This movement is effected and controlled by a link 23 pivoted at 24 to the adjacent arm 22 and pivoted at 26 to a lever 25 on a shaft 27 rotatably supported in the adjacent end frame 11. Shaft 27 extends across the machine and through the other end frame to operate the duplicate adjusting mechanism (not shown) for the other primary arm assembly. Rotation of shaft 27 may be controlled in any conventional manner to swing the arms 20 during roll changing as described hereinafter.

The remainder of the basic structure of the winder includes horizontal secondary ways 30 extending from the end frames 11 and 12 and supported near their outer ends by appropriate leg structure 31. A carriage 33 is mounted by means of linear bearings 34 for sliding movement on each of these secondary ways, and each carriage 33 has a horn 35 pivotally mounted on its outer end for retaining the core shaft of each winding roll after it has been transferred from the primary arms 20. Movement of the carriages 33 is controlled by a fluid pressure cylinder 36 mounted in each of the ways 30 and having its piston rod 37 connected to the associated carriage.

The primary arm assembly 20 on the control side of the winder shown in Fig. 1 includes means for driving a new core by force applied to the axis thereof. The structure and mode of operation of this primary arm assembly are illustrated in Figs. 2-3. The basic structural member is an arm 22 mounted by any suitable bearing structure 40 on the end frame 11 for rotation

about the axis of drum 10 between approximately 11 o'clock and 3 o'clock positions as viewed in Fig. 1.

A slide 42 is movable lengthwise of the arm 22, and its movements are controlled by a fluid pressure cylinder 43 mounted near the radially inner end of arm 20 and having its piston rod 44 pivotally connected to the slide 42. At its outer end, the slide 42 includes a portion forming a saddle 45 proportioned to receive and support the bearings 46 on one end of a core shaft 50 having a core C, or more probably a set of core sections C in end to end relation, mounted thereon in preparation for the winding of a new roll of web material W.

When a core shaft 50 is mounted in the saddle 45, it is rotatably held therein by the system of links and a fluid pressure cylinder shown in Fig. 2. More specifically, an arm 51 is pivoted at 52 to the slide 42, and it carries at its outer end a roller 53 which is movable into and out of rotatable engagement with a groove 54 in the bearings 47 on each core shaft 50 supported in saddle 45.

The arm 51 is moved into and out of the locked shaft-retaining position shown in Fig. 2 by a toggle linkage which includes a link 55 pivotally connected thereto and to a bell crank 56 pivotally mounted at 57 to the slide 42. The bell crank 56 can be rocked back and forth about its pivot 57 by a fluid pressure cylinder 58 pivotally mounted to the slide 42 and having its piston rod 59 pivotally connected to the bell crank 56.

The arm assembly 20 incorporates a drive for directly driving a core shaft 50 mounted in the saddle 45 in all positions of the slide on the arm 22. This drive includes a motor 60 mounted outboard of the end frame 11 by a bracket 61 as shown in Fig. 3. With the motor 60 mounted vertically as shown, its drive shaft 62 leads into a right angled transmission 63 having an output shaft 64 coaxial with the drum 10 and carrying a pulley

65 which drives a double-faced timing belt 66 and is therefore a sprocket, the belt 66 being omitted in Fig. 3.

As viewed in Fig. 2, the sprocket 65 rotates counterclockwise so that the belt 66 travels around an idler 70 journalled in the arm 22 to a second idler 71 journalled in the slide 42 and then around a sprocket 72 on a shaft 73 journalled in the slide 42. From the sprocket 72, the belt travels around an idler 74 journalled in the slide 42 to and around a rotary idler 75 mounted for vertical adjustment in the end of the arm 22 for take-up of the belt 66. From the take-up idler 75, the belt travels downwardly to and around an idler 76 journalled in the arm 22 to the drive sprocket 65.

The driving force applied to the sprocket 72 is transmitted directly to a core shaft 50 mounted in the saddle 45. More specifically, the sprocket shaft 73 extends into overlapping relation with the end portion of a core shaft 50, and the shaft 73 carries a spur gear 77 which meshes with a spur gear 78 on the adjacent end of the core shaft 50. Preferably, all of these drive parts will be enclosed by a suitable cover and therefore are not seen in Fig. 1.

It will accordingly be seen that with this drive arrangement, the drive from the motor 60 is transmitted directly through the belt 66 to a core shaft 50 mounted in the saddle 46. In addition, this drive is not affected by the position of the slide 42 on the arm 22. More specifically, whenever the position of the slide 42 on arm 22 is changed, the sprocket 72 will track on the belt 66, but its driving engagement with the belt will remain constant.

This is an important feature of the invention, because it makes it possible to apply a driving force to a newly started roll through its rotational axis at an appropriately controlled rotational speed without being

affected by the increasing diameter of the roll and the correspondingly reduced angular speed of the core shaft 50. It will be understood that this drive is provided on only one of the arm assemblies 20, and the other arm assembly includes only a slide 42 and the associated mechanism for moving that slide and for releasably mounting the other end of a core shaft in the saddle 45 on that slide 42.

Another important feature is the provision for maintaining an axially applied driving force to a winding roll while it is being transferred to the carriages 33 on the secondary ways 30 and while it thereafter continues to wind on the secondary ways. Referring to Figs. 4-5, a motor 80 is mounted separately from the winder at any convenient location along the secondary ways 30, such preferably as approximately mid-way between the position of the carriages 33 when a winding roll is first deposited thereon from the primary arms and the position of the carriages 33 when the roll is fully wound.

The motor 80 is located on the opposite (back) side of the winder from the primary arm drive because the drive of which it is a part requires a different component on the adjacent end of each core shaft 50. The motor 80 is shown in Fig. 5 as mounted on a separate stand 81, although another mounting may be used as described hereinafter, and is omitted from Fig. 4 in the interests of clarity.

The motor 80 is connected through a belt or gear drive 82 with a relatively short drive shaft 83 mounted on the motor itself or on the stand 81 and extending at right angles to the length of the winder. The shaft 83 is connected by a universal joint 84 with one end of a compound telescoping shaft 85 having its other end connected through a universal joint 86 with a spindle 88 which is selectively connected through a

clutch mechanism 90 with a core shaft 50 supported on the adjacent secondary way carriage 33.

The clutch mechanism 90 includes a housing 92 supported by a bracket 93 on the carriage 33. Referring to Fig. 6, the spindle 88 is mounted by ball bearings 94 in a sleeve 95 supported for rotational and axial movement in the housing 92 by a sleeve bearing 96. A female coupling member 99 is secured to the end thereof adjacent the carriage 33, and this coupling member is internally grooved and proportioned for a splined driving fit with a complementary male coupling member 100 which is provided on the adjacent end of each core shaft 50. It is accordingly necessary that the housing 92 be located to align the spindle 88 with a core shaft 50 supported on the associated carriage 33.

Movement of the clutch members 99 and 100 into and out of engaged position is effected and controlled by a fluid pressure cylinder 101 mounted on the bracket 93 and having its piston rod connected by an arm 102 with the spindle 88 through the bearings 94 at the adjacent end of sleeve 95. Fig. 6 shows the clutch members in engaged position, and it will be understood that the cylinder 101 can be operated through a stroke of sufficient length to pull the female clutch member 99 free of the male clutch member 100, i.e. to the right as viewed in Fig. 6.

In describing the operating cycle of this winder, it is assumed that a roll R is substantially fully wound, and that it is necessary to transfer the web to a new core C on a core shaft 50 supported in the primary arm assemblies 20. The first step is to bring the new core C up to a surface speed matching that of the drum 10 while the core is held out of engagement with the drum by appropriate control of the cylinders 44. The operation of cutting and transferring the web is preferably carried out by means of a knife 110 which is

stationary during the roll changing operation in accordance with co-owned Tetro U.S. Patent No. 4,422,586 of 1983.

More specifically, the knife 110 is carried by arm assemblies 111 pivotally mounted at 112 on each of the end frames 11 and 12 so that it can be swung from the rest position shown in dotted lines in Fig. 1 to the cutting position shown fragmentarily in full lines in Fig. 1. Each new core 50 C may comprise a plurality of individual core sections mounted end-to-end on the shaft 50, each section for winding one of the split sections of the web W. The core has one or more adhesive strips thereon to which the web adheres when the core is brought into engagement therewith against the drum 10, and as the web is thereby lifted away from the drum, it is drawn into contact with the knife 110 and thereby immediately severed and caused to start to wind on the new core.

During this short interval in which the cutting and transfer of the web is carried out, the core is being driven, at the same surface speed, both through the drive carried in one of the primary arms and by surface engagement with the drum 10 through the web. As soon as the transfer of the web has been completed, the control of the primary arm drive motor 60 is shifted from a speed mode to a torque mode to transmit predetermined torque to the core shaft 50 through the gears 77 and 78.

This torque is controlled in accordance with the nature of the specific web material being processed to maintain the desired torque while at the same time reflecting that the angular (rpm) speed of the core shaft constantly decreases as required by the increase in diameter of the winding roll. It is during this phase of the operation that the novel belt and gear drive of the core shaft is particularly important in making it possible for the core shaft to move upwardly in the arm assemblies 20 without affecting the drive thereto through

gears 77 and 78. At the same time, the nip pressure of the winding roll against the drum is under the constant control of the cylinders 43, which can increase or decrease the gravitational load of the winding roll on the drum to establish and maintain desired nip pressure.

When the fully wound roll R has been moved to the broken line position shown in Fig. 1, the winding roll is transferred to the secondary ways by swinging the primary arm assemblies through an arc in the usual manner, through shaft 27, levers 25 and links 23, until the bearings 46 on the core shaft are received on the secondary ways 30. While this movement is taking place, the drive motor 80 is actuated to bring the spindle 88 up to an angular speed slightly greater, preferably one percent, than the angular speed of the core shaft supporting the winding roll.

As soon as this speed relation is attained after the core shaft has reached the secondary ways 30, and the horns 35 on carriages 33 have been brought forward by the cylinders 43 to meet the core shaft bearings 96, the cylinder 101 is actuated to engage the clutch members 99 and 100. Engagement and disengagement of these clutch members are preferably verified by means such as proximity switches 115 (Fig. 6). The drive by motor 80 is then changed from a speed mode to a torque mode to apply the desired torque drive to the opposite end of the core shaft from its end connected with the drive in one primary arm, and the primary arm motor is switched from torque mode to speed mode.

Then the toggle linkages 55-56 on the primary arm assemblies are released, because the core shaft is now held by the horns 35, and the nip pressure between the winding roll and the drum is under the control of the cylinders 43. As the winding roll R^1 increases in diameter and thereby moves its core shaft 50 out of the saddles 45 as shaft 50 moves away from drum 10 on

carriages 33, the spur gear 78 on one end of the core shaft moves out of meshing engagement with its drive gear 77, but the torque mode drive continues to be applied to the other end of the core shaft. The primary arms can then be returned to their upright position for receiving a new core shaft.

As the carriages 33 then continue to move away from the drum 10 as the winding roll builds up, the telescoping shaft 88 moves about its universal joint connections to compensate for the movement of the core shaft and the carriages 33, as illustrated in Fig. 7. This arrangement is simpler than having the motor 80 mounted directly on one of the carriages 33, because it correspondingly reduces the weight carried by that carriage. In either case, since the weight of the drive parts cantilevered from the carriage is substantial, the linear bearings 34 are important to the operation of the winder by providing practical compensation for that weight load. In an alternative construction, the motor 80 can be mounted by linear bearings on a stand parallel with the adjacent secondary way for movement with the adjacent carriage, in which case the motor shaft would be connected with the spindle 82 by a 90° gear box.

Thus to summarize, the complete cycle of starting and winding each new roll is initiated by driving the prepared core at a surface speed matching the surface speed of the driving drum until the web has been cut and transferred to the new core. Immediately thereafter, while winding is continued by surface driving the roll R^1 winding on the core, the axially applied separate drive which previously was regulated to match the surface speed of the drum is shifted to a torque mode wherein it will attempt to cause the winding roll to overspeed the drum. This applied torque drive can be maintained in the same differential relation with the surface drive, while the rpm of the core necessarily

decreases and the roll builds up, or it can be varied as determined to be appropriate to adjust the degree of hardness in the roll at different thicknesses.

In addition to maintaining this torque mode driving of the new roll in the primary arms, it is also maintained after the winding roll has been transferred to the secondary way carriages, but with the torque mode drive being transferred from one end of the core shaft to the other after the primary arms deliver the roll to the secondary way carriages and are retracted to their raised positions wherein they receive another core shaft carrying the next core on which the web is to be wound.

The apparatus and method of the invention accordingly make it possible to drive each winding roll by both surface contact and center winding torque from start to finish for each core or set of cores on a common core shaft. The resulting control of roll hardness and quality is definitely superior to what can be accomplished in this respect by the previous technology.

In the preferred practice of the invention, the complete cycle for the roll or rolls wound on each core shaft is under the control of a microprocessor 120 programmed in accordance with conventional computer technology as required to establish a predetermined relation between the angular speed of each drive applied to the core shaft and the actual angular speed at which it is driven by the drum. More specifically, the center drives are controlled to apply a torque which would cause the core shaft to rotate faster, by a predetermined percentage, than its actual rotational rate imparted by the drum, and thereby to develop greater tension in the web and to cause it to wind more tightly.

The differential between the rotational rates or torsional forces developed by the two drives can and should be varied in accordance with both the nature of the web material itself and the extent to which the

degree of hardness (tightness) of a roll of that material should vary throughout the radius of the roll. It is therefore not practical to predict in advance the optimum operating condition for the winder of the invention in winding specific web materials, but in general it can be predicted that the center drive should be controlled to apply a torque to the core shaft which would drive it 3 to 5% faster than its actual speed as determined by the driving drum.

It is also necessary that the differential between the two drives reflect the continuous decrease in the rotational speed of the core shaft as the radius of the winding roll increases while its surface speed remains constant, and this necessity is taken care of by maintaining the speed differential as a percentage. In general, in order to obtain uniform hardness, the torque mode drive should be proportional to the radius of the winding roll, but the percentage differential between the two drives should remain the same. If, however, it is desired that the hardness or tightness decrease as the roll radius increases, the torque proportional to the roll radius should decrease as the roll radius increases.

What is claimed is:

1. Apparatus for continuously winding a web material into rolls on successive cores mounted on successive core shafts, comprising:

(a) a winder drum,

(b) means for driving said drum at a predetermined constant surface speed,

(c) means for directing a continuous web material into partially wrapping engagement with said drum,

(d) a pair of primary arms mounted for pivotal movement about the axis of said drum,

(e) means on said arms for receiving and supporting a core shaft having a core thereon for movement in said arms from a position in which said core is in contact with said web on said drum to a position away from said drum,

(f) drive means associated with one of said arms for driving each core shaft supported in said arms by force applied about the axis thereof independently of and simultaneously with driven surface engagement of said core on said shaft with said drum,

(g) means effective upon engagement of said core with said drum through said web for cutting said web and causing the resulting cut leading end of said web to adhere to said core,

(h) secondary support means positioned to receive from said primary arms a core shaft having thereon a partially wound roll,

(i) means for causing transfer of a core shaft having thereon a partially wound roll from said primary arms to said second support means while retaining said roll in driven engagement with said drum through said web, and

(j) means for driving said transferred core shaft by force applied about the axis thereof independently of said arm-carried drive means while said

partially wound roll thereon is in engagement with said drum through said web.

2. Winding apparatus as defined in claim 1 wherein said drive means are associated with one of said arms on one side of said apparatus and apply force to only one end of each said core shaft, and said means for driving said transferred partially wound core are located on the opposite side of said apparatus and apply said force to the opposite end of said core shaft.

3. Winding apparatus as defined in claim 2 wherein said drive means comprises a transmission carried by said one arm and including a driving gear supported on said arm for movement thereon toward and away from said drum, a gear on each said core shaft, and means for releasably maintaining said gears in mesh while said core shaft moves on said arms radially of said drum.

4. Winding apparatus as defined in claim 1 wherein said drive means carried by one of said arms comprises a driving pulley mounted coaxially with said drum, a second pulley adjacent the radially outer end of said arm, an endless belt encircling said first and second pulleys, a slide movable on said arm between said pulleys and including means for supporting one end of a core shaft having a core mounted thereon, a third pulley mounted on said slide in driven engagement with said belt and movable with said slide while maintaining driven engagement with said belt, and meshing gears on said third pulley and each said core shaft for transmitting the driving force of said belt to said core shaft.

5. Winding apparatus as defined in claim 4 further comprising a stationarily mounted motor, and means for transmitting drive from said motor to said driving pulley.

6. Winding apparatus as defined in claim 4 further comprising frame means whereon said drum is rotatably supported, a motor mounted in stationary relation with said frame means, and means providing said motor with an output shaft whereon said driving pulley is mounted.

7. Winding apparatus as defined in claim 3 wherein said pulleys are sprockets, and said belt is a timing belt in driven engagement with said first sprocket and driving engagement with said third sprocket.

8. Winding apparatus as defined in claim 1 wherein said means for driving said partially wound core comprise a drive shaft mounted on said secondary support means on the opposite side of said winder from said drive means carried by one of said arms, and means for selectively providing driving engagement between said drive shaft and the adjacent end of a core shaft supported in said secondary support means.

9. Winding apparatus as defined in claim 1 wherein said secondary support means include substantially horizontal ways, carriages mounted on said way for movement toward and away from said drum to receive and support the opposite ends of each said core shaft, and wherein said means for driving said transferred core shaft includes driving means carried by one of said carriages for coupling to and travel with each core shaft supported on said carriage.

10. Winding apparatus as defined in claim 9 wherein said one carriage is mounted on the associated said way by linear bearings.

11. Winding apparatus as defined in claim 10 further comprising means for controlling each of said core shaft drive means and driving means to apply to each said core shaft driven thereby a torque which exceeds by a predetermined percentage the torque developed by the surface driving of the roll winding on said core shaft.

12. Apparatus for continuously winding a web material into rolls on successive cores mounted on successive core shafts, including a winder drum, driving said drum at a constant surface speed, means directing a continuous web material into partially wrapping engagement with said drum, a pair of primary arms mounted for pivotal movement about the axis of said drum and including means for receiving and supporting a core shaft having a core thereon for movement in said arms from a position wherein said core is spaced away from said drum to a position wherein said core is in contact with said web on said drum, and drive means for driving each core shaft supported in said arms by force applied about the axis thereof independently of and simultaneously with driven surface engagement of said core on said shaft with said drum, said drive means comprising:

(a) a driving pulley supported in coaxial relation with said drum adjacent one end of one of said arms,

(b) means for driving said pulley,

(c) a second pulley adjacent the opposite end of said one arm,

(d) an endless belt encircling said first and second pulleys,

(e) a slide movable on said one arm between said pulleys and including means for supporting one end of a core shaft having a core mounted thereon,

(f) a third pulley mounted on said slide in driven engagement with said belt and movable with said slide while maintaining driven engagement with said belt, and

(g) meshing gears on said third pulley and said core shaft for transmitting the driving force of said belt to said core shaft.

13. Apparatus as defined in claim 12 wherein said pulleys are sprockets, and said belt is a timing belt in driven engagement with said first sprocket and driving engagement with said third sprocket.

14. Apparatus as defined in claim 12 wherein said timing belt is double sided, and said third sprocket is in driven engagement with the outer side of said belt.

15. The method of continuously winding a web material into rolls on successive cores in combination with a winder drum, a pair of primary arms mounted for pivotal movement about the axis of said drum, and secondary support means for receiving a partially wound roll from said primary arms, said method comprising the steps of:

(a) driving said drum at a predetermined constant surface speed,

(b) directing a continuous web material into partially wrapping engagement with said drum,

(c) supporting a core shaft having a core thereon for movement in said arms toward and away from said drum,

(d) applying a driving force about the axis of each core shaft supported in said arms to bring said core thereon up to the surface speed of said drum while supporting said core out of contact with said drum,

(e) moving said driven core into engagement with said drum through said wrapping portion of said web,

(f) cutting said web and causing the resulting cut leading end of said web to adhere to said core and to wind roll thereon,

(g) continuing to apply driving force about the axis of each said core shaft while maintaining said core thereon in driven engagement with said drum through said web winding thereon,

(h) transferring said core shaft from said primary arms to said secondary support means while retaining said winding roll in driven engagement with said drum and while continuing to apply driving force about the axis of said core shaft, and

(i) continuing to apply driving force about the axis of said transferred core shaft while said core shaft is supported by said secondary support means and

while maintaining said winding roll in driven engagement with said drum.

16. The method as defined in claim 15 comprising the further step of varying said driving force applied to each core shaft supported by said secondary support means to effect corresponding variation in the tightness with which the roll is wound thereon.

17. The method defined in claim 15 wherein said driving force is applied to one end of each core shaft supported in said primary arms, and said driving force is applied to the other end of each said core shaft supported on said secondary support means.

18. The method defined in claim 15 wherein driving force is applied to both ends of said core shaft supported by said secondary support means for a limited interval after following transfer of said core shaft to said secondary support means, and thereafter said driving force applied to said one end of said core shaft is discontinued.

19. The method defined in claim 14 wherein said driving force applied to said core shaft is controlled to develop a torque force which is a predetermined percentage greater than the torque force applied to the roll winding thereon by the driving engagement between said drum and said winding roll.

20. The method of continuously winding a web material on successive cores mounted on successive core shafts and in combination with a winder drum, a pair of primary arms mounted for pivotal movement about the axis of said drum and including means for receiving and supporting a core shaft having a core thereon, and secondary support means positioned to receive from said primary arms a core shaft having thereon a partially wound roll, said method comprising the steps of:

(a) driving said drum at a constant surface speed,

(b) temporarily supporting a core on a core shaft on said arms in spaced relation with said drum while said web material is traveling along said drum,

(c) driving said core shaft by force applied to one end thereof about the axis thereof at a surface speed matching said drum surface speed,

(d) bringing said driven core into driven engagement with said drum through traveling web,

(e) severing said web and attaching the resulting leading end thereof to said web to initiate a winding roll while maintaining said winding roll in driven engagement with said drum,

(f) switching said driving force to said core shaft to a torque mode creating a torque greater than the torque developed by said drum surface drive,

(g) transferring said winding roll from said primary arms to said secondary means while continuing to apply both of said driving forces thereto,

(h) driving said transferred core shaft by force applied about the axis thereof independently of said driving force applied to said one end thereof while said partially wound roll thereon is in engagement with said drum through said web, and

(i) discontinuing said drive applied to said one end of said core shaft.

AMENDED CLAIMS

[received by the International Bureau on 29 August 1994 (29.08.94); original claims 1,4,6-9,12-15 and 17-20 amended; remaining claims unchanged (8 pages)]

1. Apparatus for continuously winding a web material into rolls on successive cores mounted on successive core shafts, comprising:

(a) a winder drum,

(b) means for driving said drum at a predetermined constant surface speed,

(c) means for directing a continuous web material into partially wrapping engagement with said drum,

(d) a pair of primary arms mounted for pivotal movement about the axis of said drum,

(e) means on said arms for receiving and supporting a core shaft having a core thereon for movement in said arms from a position in which said core is in contact with said web on said drum to a position away from said drum,

(f) drive means associated with one of said arms for driving each core shaft supported in said arms by force applied to said core shaft about the axis thereof independently of and simultaneously with driven surface engagement of said core on said shaft with said drum,

(g) means effective upon engagement of said core with said drum through said web for cutting said web and causing the resulting cut leading end of said web to adhere to said core,

(h) secondary support means positioned to receive from said primary arms a core shaft having thereon a partially wound roll,

(i) means for effecting transfer of a core shaft having thereon a partially wound roll from said primary arms to said secondary support means while retaining said roll in driven engagement with said drum through said web,

(j) driving means for driving said transferred core shaft by force applied to said core shaft about the

axis thereof independently of said arm-associated drive means, and

(k) means for maintaining said partially wound roll on said transferred core shaft in engagement with said drum through said web for simultaneous drawing by said drum and by said driving means.

2. Winding apparatus as defined in claim 1 wherein said drive means are associated with one of said arms on one side of said apparatus and apply force to only one end of each said core shaft, and said means for driving said transferred partially wound core are located on the opposite side of said apparatus and apply said force to the opposite end of said core shaft.

3. Winding apparatus as defined in claim 2 wherein said drive means comprises a transmission carried by said one arm and including a driving gear supported on said arm for movement thereon toward and away from said drum, a gear on each said core shaft, and means for releasably maintaining said gears in mesh while said core shaft moves on said arms radially of said drum.

4. Winding apparatus as defined in claim 1 wherein said drive means associated with one of said arms comprises a driving pulley mounted coaxially with said drum, a second pulley adjacent the radially outer end of said arm, an endless belt encircling said first and second pulleys, a slide movable on said arm between said pulleys and including means for supporting one end of a core shaft having a core mounted thereon, a third pulley mounted on said slide in driven engagement with said belt and movable with said slide while maintaining driven engagement with said belt, and meshing gears on said third pulley and each said core shaft for transmitting the driving force of said belt to said core shaft.

5. Winding apparatus as defined in claim 4 further comprising a stationarily mounted motor, and means for transmitting drive from said motor to said driving pulley.

6. Winding apparatus as defined in claim 4 further comprising frame means rotatably supporting said drum, a motor mounted in stationary relation with said frame means, and said motor having an output shaft whereon said driving pulley is mounted.

7. Winding apparatus as defined in claim 3 wherein said pulleys are sprockets, and said belt is a timing belt in driven engagement with said first pulley and driving engagement with said third pulley.

8. Winding apparatus as defined in claim 1 wherein said means for driving said partially wound core comprise a drive shaft mounted on said secondary support means on the opposite side of said winder from said drive means associated with one of said arms, and means for selectively providing driving engagement between said drive shaft and the adjacent end of a core shaft supported by said secondary support means.

9. Winding apparatus as defined in claim 1 wherein said secondary support means include substantially horizontal ways, carriages mounted on said ways for movement toward and away from said drum to receive and support the opposite ends of each said core shaft, and wherein said means for driving said transferred core shafts includes driving means carried by one of said carriages for coupling to and travel with each core shaft supported on said carriage.

10. Winding apparatus as defined in claim 9 wherein said one carriage is mounted on the associated said way by linear bearings.

11. Winding apparatus as defined in claim 10 further comprising means for controlling each of said core shaft drive means and driving means to apply to each said core shaft driven thereby a torque which exceeds by a predetermined percentage the torque developed by the surface driving of the roll winding on said core shaft.

12. Apparatus for continuously winding a web material into rolls on successive cores mounted on successive core shafts, including a winder drum, means for driving said drum at a constant surface speed, means directing a continuous web material into partially wrapping engagement with said drum, a pair of primary arms mounted for pivotal movement about the axis of said drum and including means for receiving and supporting a core shaft having a core thereon for movement in said arms from a position wherein said core is spaced away from said drum to a position wherein said core is in contact with said web on said drum, and drive means for driving each core shaft supported in said arms by force applied to said core shaft about the axis thereof independently of and simultaneously with driven surface engagement of said core on said shaft with said drum, said drive means comprising:

(a) a driving pulley supported in coaxial relation with said drum adjacent one end of one of said arms,

(b) means for driving said pulley,

(c) a second pulley adjacent the opposite end of said one arm,

(d) an endless belt forming a closed loop encircling said first and second pulleys,

(e) a slide movable on said one arm between said pulleys and including means for supporting one end of a core shaft having a core mounted thereon,

(f) a third pulley mounted on said slide in driven engagement with said belt and movable with said slide while maintaining driven engagement with said belt, and

(g) meshing gears on said third pulley and said core shaft for transmitting the driving force of said belt to said core shaft.

13. Apparatus as defined in claim 12 wherein said pulleys are sprockets, and said belt is a timing belt in driven engagement with said first pulley and driving engagement with said third pulley.

14. Apparatus as defined in claim 13 wherein said timing belt is double sided, and said third pulley is in driven engagement with the outer side of said belt loop.

15. The method of continuously winding a web material into rolls on successive cores in combination with a winder drum, a pair of primary arms mounted for pivotal movement about the axis of said drum, and secondary support means for receiving a partially wound roll from said primary arms, said method comprising the steps of:

(a) driving said drum at a predetermined constant surface speed,

(b) directing a continuous web material into partially wrapping engagement with said drum,

(c) supporting in said arms a core shaft having a core thereon for movement in said arms toward and away from said drum,

(d) applying a driving force to one end of and about the axis of each core shaft supported in said arms to bring said core thereon up to the surface speed of said drum while supporting said core out of contact with said drum,

(e) moving said driven core into engagement with said drum through said wrapping portion of said web,

(f) cutting said web and causing the resulting cut leading end of said web to adhere to said core and to wind roll thereon,

(g) continuing to apply said driving force about the axis of each said core shaft while maintaining said core thereon in driven engagement with said drum through said web winding thereon,

(h) transferring said core shaft from said primary arms to said secondary support means while retaining said winding roll in driven engagement with said drum and while continuing to apply driving force about the axis of said core shaft, and

(i) continuing to apply driving force to and about the axis of said transferred core shaft while said core shaft is supported by said secondary support means

and while maintaining said winding roll in driven engagement with said drum.

16. The method as defined in claim 15 comprising the further step of varying said driving force applied to each core shaft supported by said secondary support means to effect corresponding variation in the tightness with which the roll is wound thereon.

17. The method defined in claim 15 wherein said driving force is applied to one end of each core shaft supported in said primary arms, and said driving force is applied to the other end of said core shaft when said shaft is supported on said secondary support means.

18. The method defined in claim 15 wherein driving force is applied to both ends of said core shaft supported by said secondary support means for a limited interval following transfer of said core shaft to said secondary support means, and thereafter said driving force applied to said one end of said core shaft is discontinued.

19. The method defined in claim 15 wherein said driving force applied to said core shaft is controlled to develop a torque which is a predetermined percentage greater than the torque applied to the roll winding thereon by the driving engagement between said drum and said winding roll.

20. The method of continuously winding a web material on successive cores mounted on successive core shafts and in combination with a winder drum, a pair of primary arms mounted for pivotal movement about the axis of said drum and including means for receiving and supporting a core shaft having a core thereon, and secondary support means positioned to receive from said primary arms a core shaft having thereon a partially wound roll, said method comprising the steps of:

(a) driving said drum at a constant surface speed,

(b) temporarily supporting a core on a core shaft on said arms in spaced relation with said drum while said web material is traveling along] on said drum,

(c) driving said core shaft by force applied to one end thereof about the axis thereof at a surface speed matching said drum surface speed,

(d) bringing said driven core into driven engagement with said drum through said traveling web,

(e) severing said web and attaching the resulting leading end thereof to said core to initiate a winding roll while maintaining said winding roll in driven engagement with said drum,

(f) switching said driving force to said core shaft to a torque mode applying a torque greater than the torque developed by said drum surface drive,

(g) transferring said winding roll from said primary arms to said secondary means while continuing to apply both of said driving forces thereto,

(h) driving said transferred core shaft by force applied to and about the axis thereof independently of said driving force applied to said one end thereof while maintaining said partially wound roll thereon in driven engagement with said drum through said web, and

(i) discontinuing said drive applied to said one end of said core shaft.

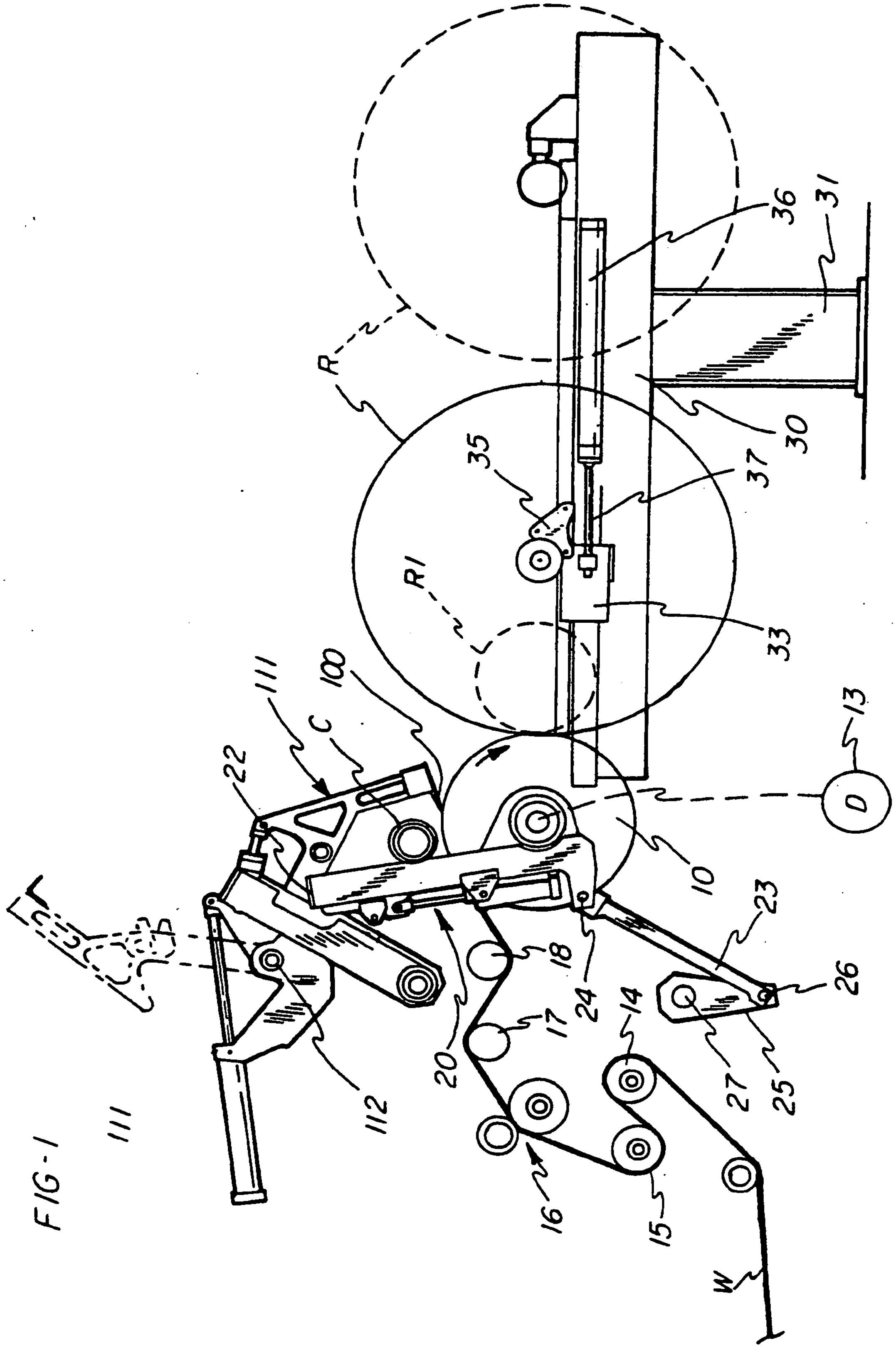
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FIG-1

FIG-2

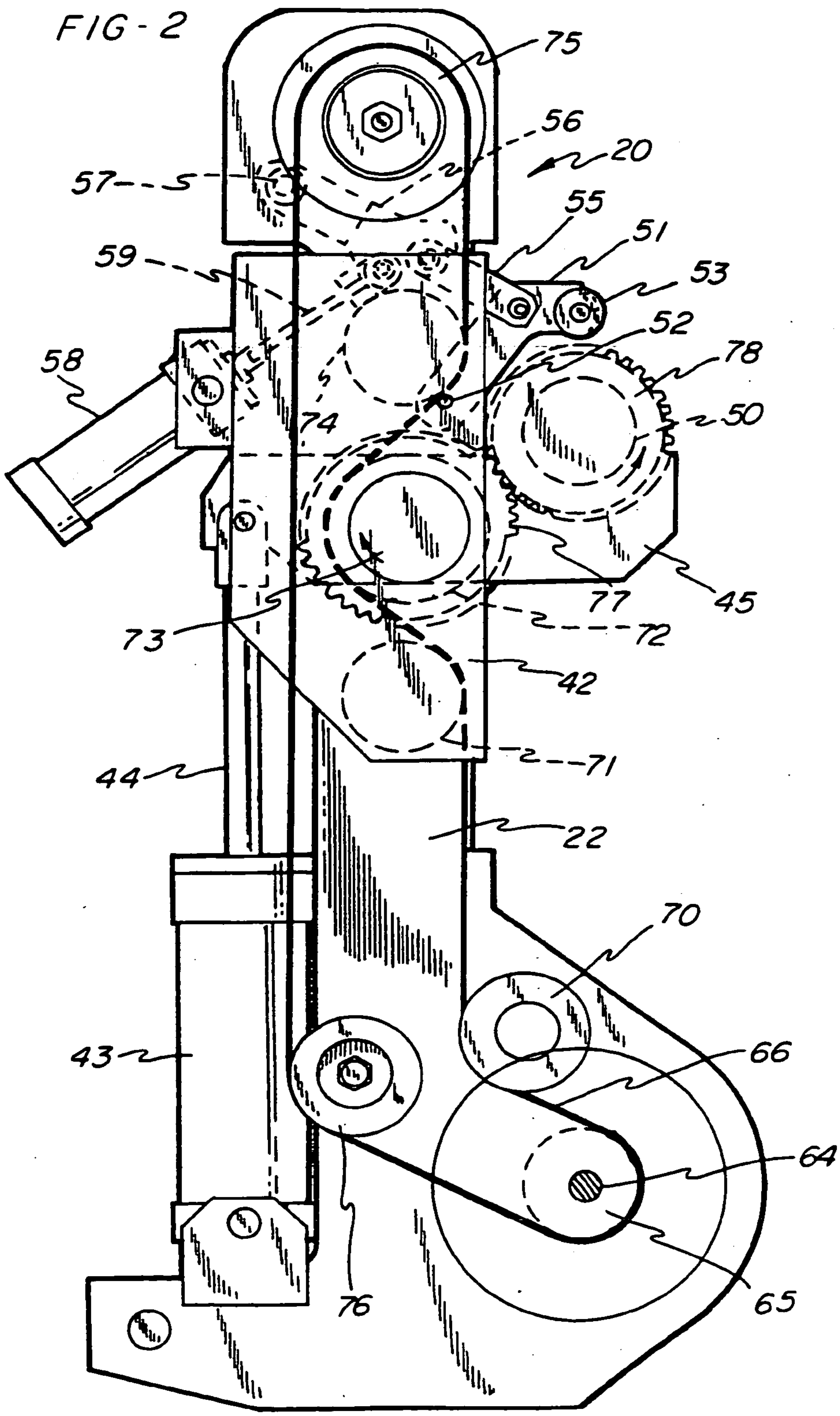
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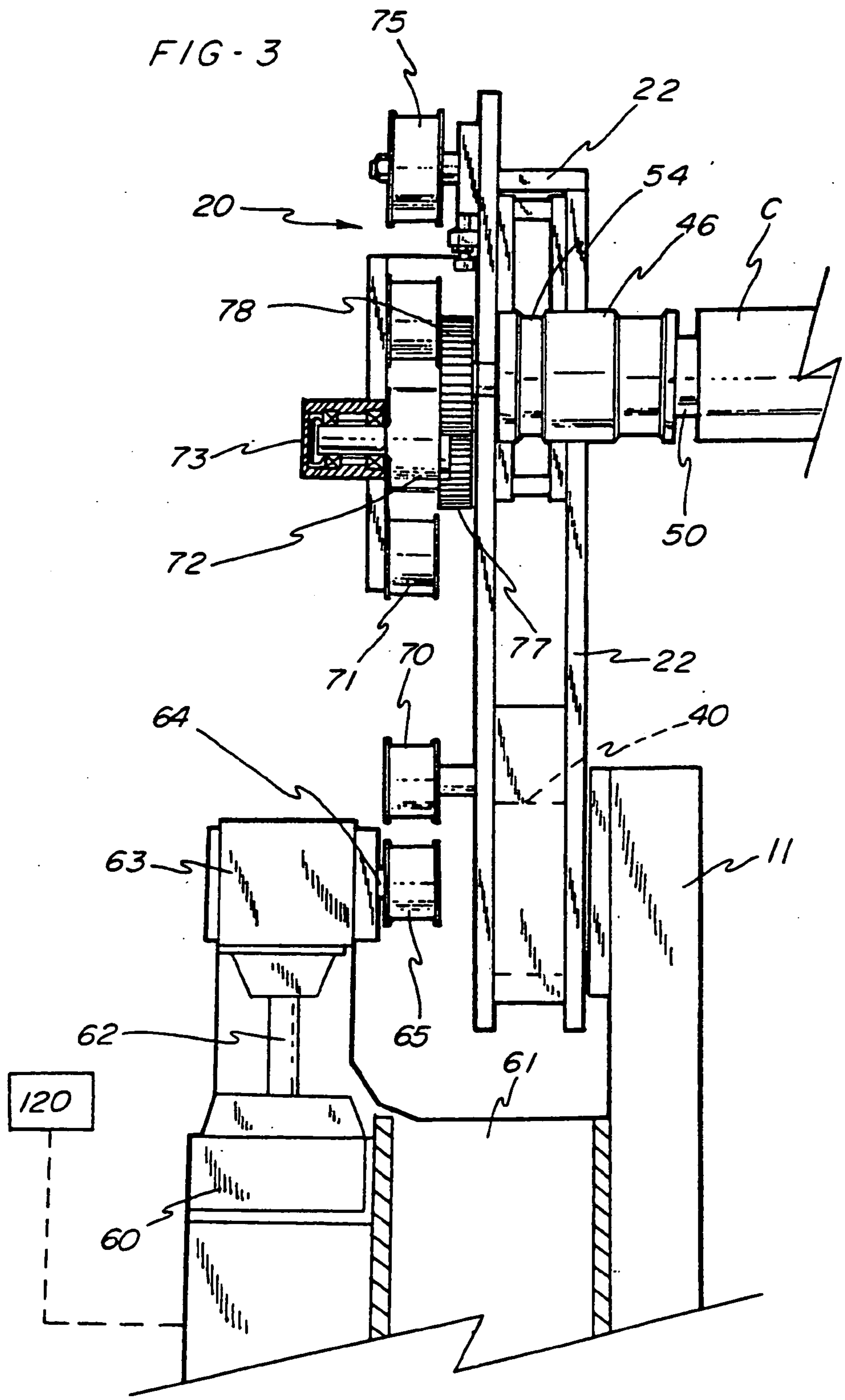
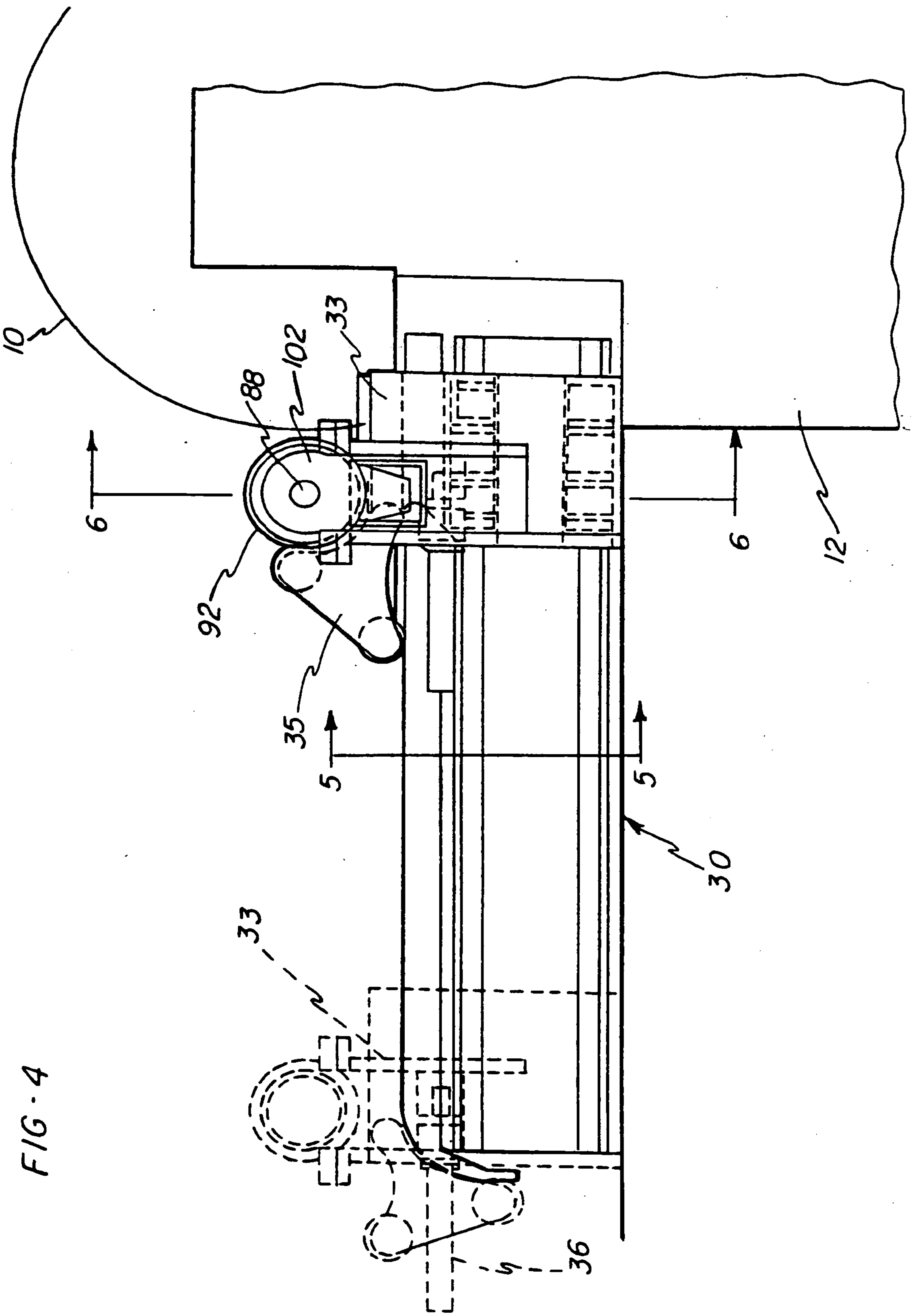
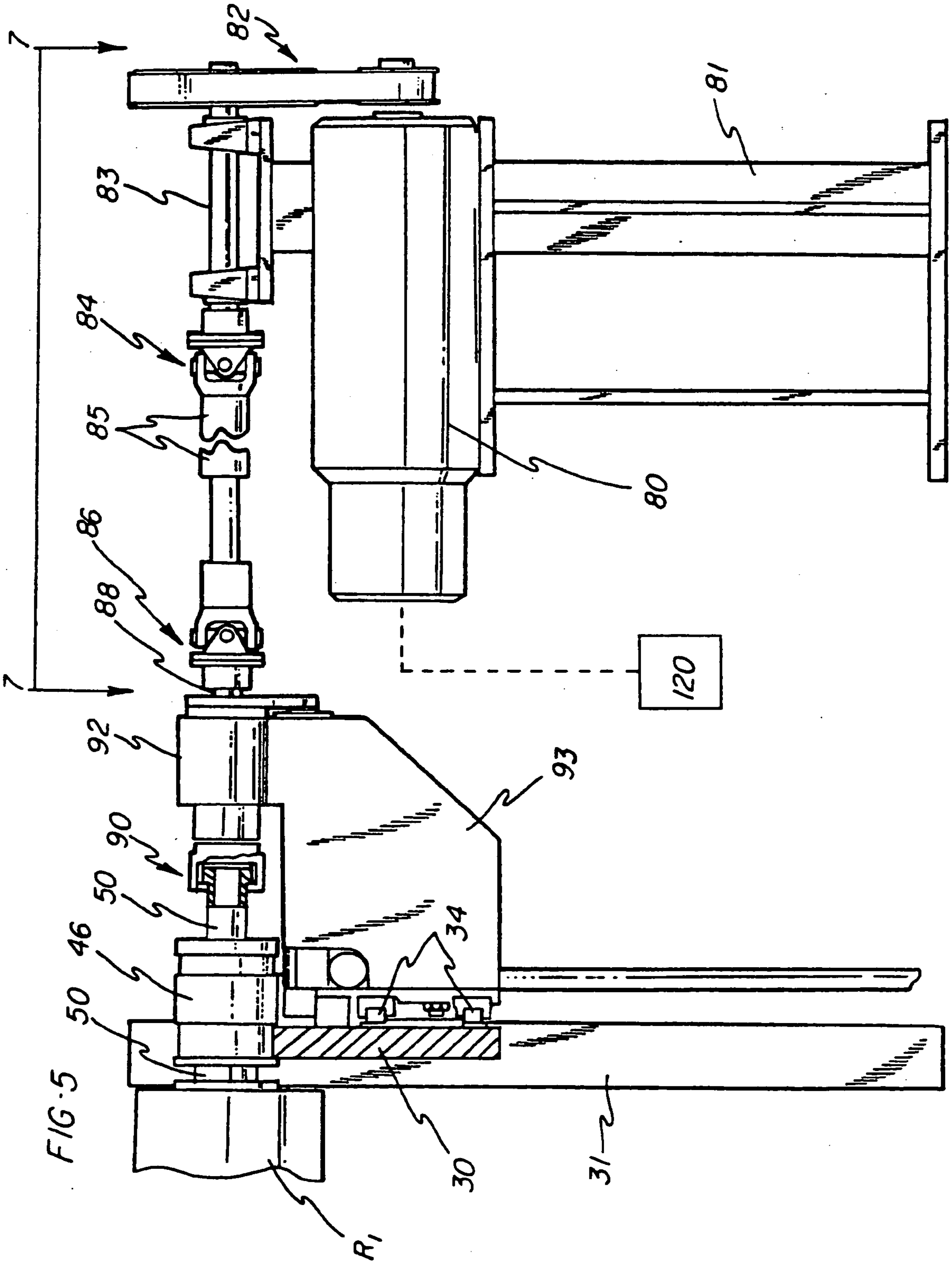
FIG - 3





FIG·4



FIG·5

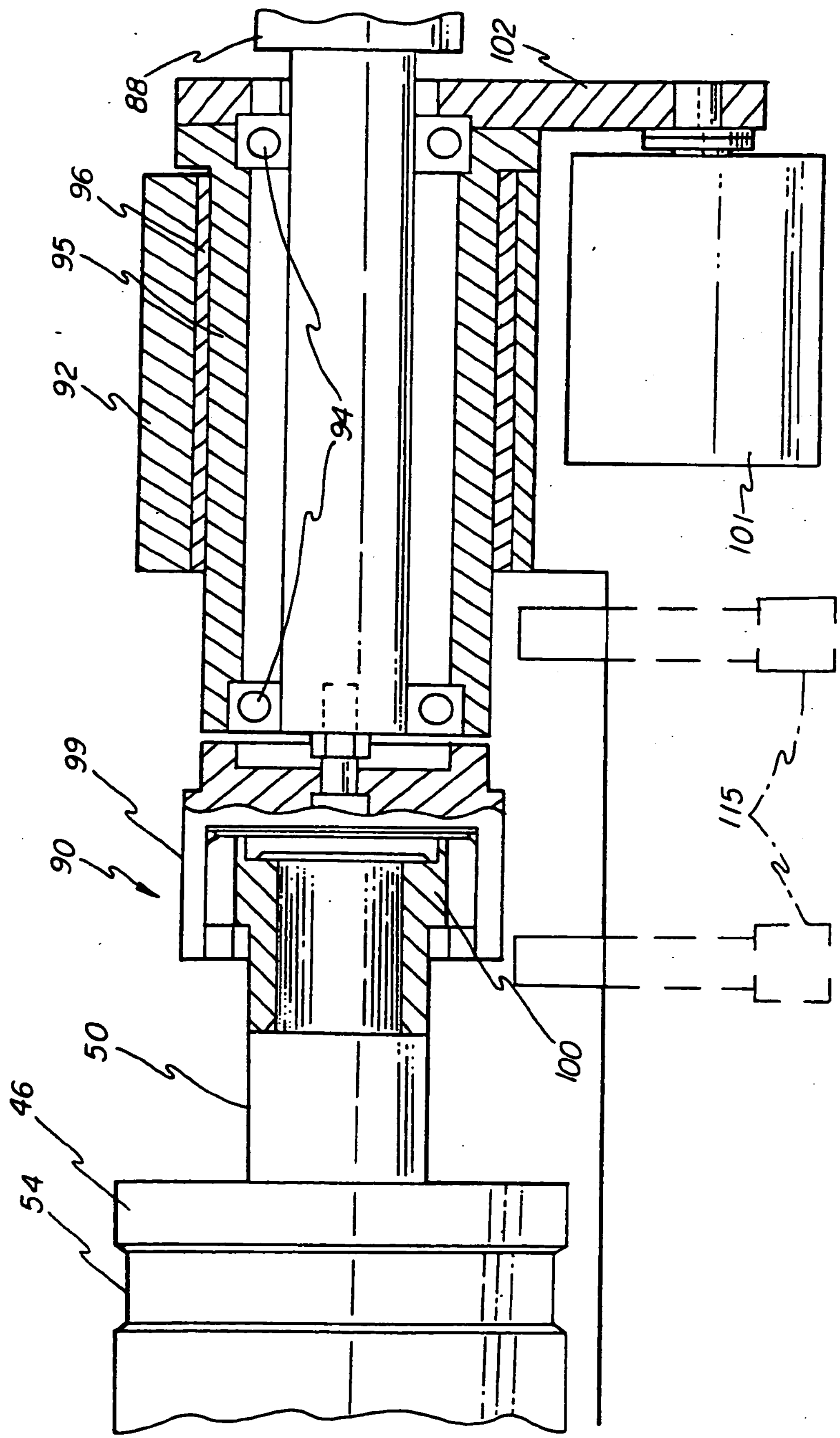


FIG - 6

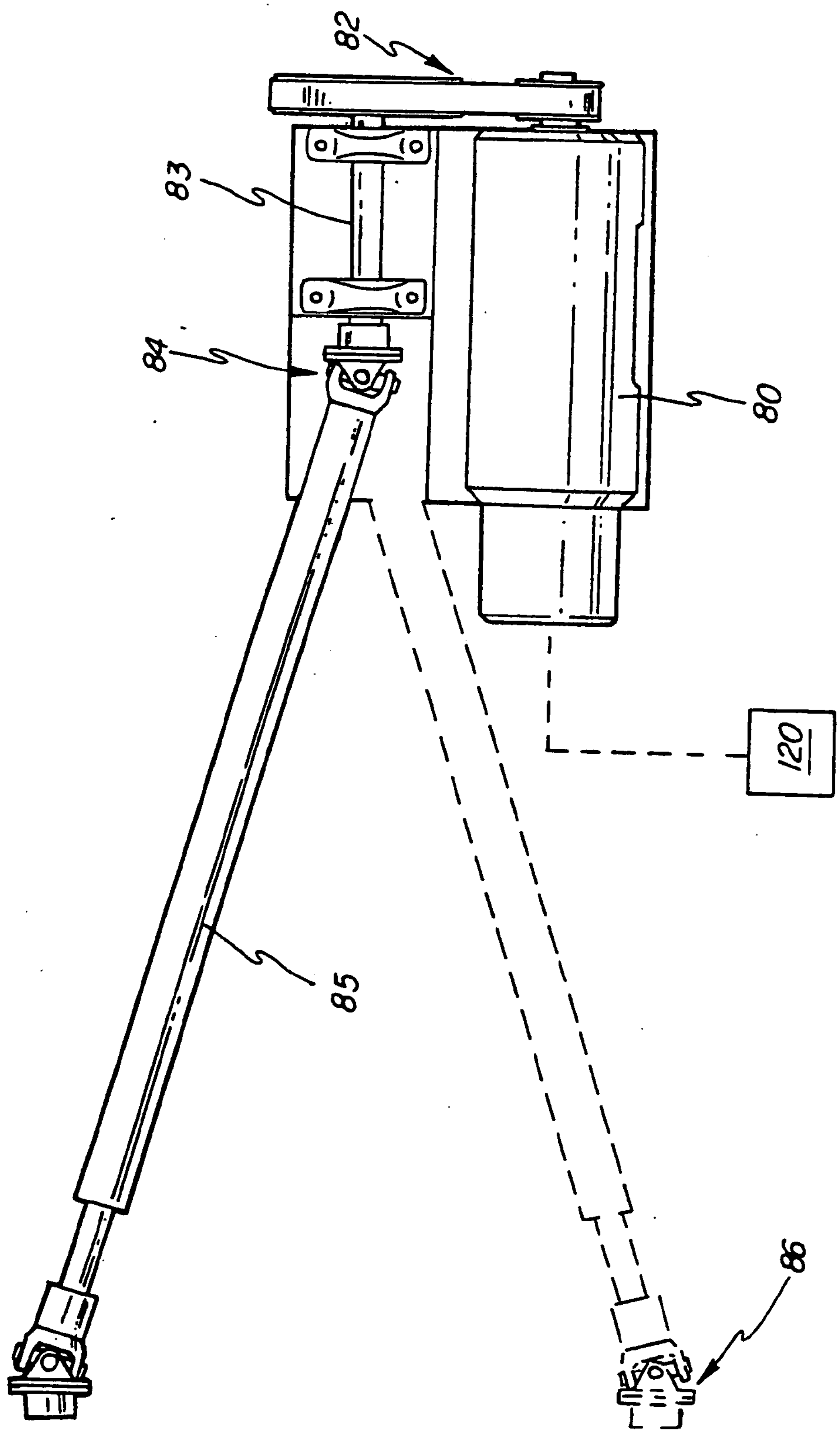


FIG-7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/04033

A. CLASSIFICATION OF SUBJECT MATTER
IPC(5) :B65H 19/30
US CL :242/065
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 242/065, 56R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, 5,064,131 (VAN BIESEN ET AL.) 12 November 1991, See entire document.	1, 2, 8, 15-18, 20
Y	US, 5,184,787 (HOLZINGER ET AL.) 09 February 1993, See entire document.	1, 2, 8, 15-18, 20
Y	US, 1,457,822 (CRANDELL) 05 June 1923, See entire document.	3-7, 12-14, 19
Y	US, 3,103,321 (JILEK) 10 September 1963, See entire document.	9-11
A	US, 5,251,835 (KYYTSÖNEN) 12 October 1993, See entire document.	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
26 MAY 1994

Date of mailing of the international search report
JUN 27 1994

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